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SYSTEM AND METHOD FOR SPOTTING MOVABLE MOLD CORES

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CROSS-REFERENCE TO RELATED APPLICATIONS

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BACKGROUND AND SUMMARY OF THE INVENTION

[0001] The present invention relates to a method and system for assisting in the spotting of a movable mold core. The present invention includes the use of a movable core spotting apparatus that allows the necessary spotting to take place in a more efficient manner than is currently possible.

[0002] An increasing number of products are being produced today via some type of molding process. A multitude of products, once manufactured from metallic compounds, for example, are now produced from lighter and less expensive materials, such as, for example, plastics. The use of such materials and manufacturing techniques often allows for a product of fewer components and of lighter weight, but one that also retains sufficient strength.

[0003] Not only has the number of products produced via molding techniques increased, but so has the complexity of the products. Whether produced by injection, compression or other molding methods, molded products now often have complex geometries. Such geometries require generally more complicated molds and manufacturing methods. For example, modern plastic molds are often equipped

with one or more slidable, or similarly movable cores, to form features such as undercuts not otherwise producible.

[0004] A typical mold, such as an injection mold, is generally comprised of two mold halves - one half containing a main cavity, and the other half having a main core. During mold development, a process generally referred to as spotting is used to ensure that clearances and areas of designed contact (shutoff) between mold halves are satisfactory. Spotting compound or another suitable marking product is generally applied to these areas of concern, and the mold is placed into a spotting press, which allows the mold halves to be repeatedly separated and reacquainted. In this manner, areas of the mold that should show contact, and do not, may be built up; while areas that should not show contact, and do, may be ground down. The spotting process may be repeated until the proper relationship between mold areas is achieved.

[0005] Just as is done with respect to the main mold halves, spotting is also used to ensure that the fit between the movable core, or cores, and the portion of the mold that receives each movable core is proper. With respect to a movable core, however, the spotting technique described above is generally not practicable. Because movable cores often move transversely, or otherwise at an angle to the general direction of movement of the main mold halves, a spotting press is generally not capable of imparting the proper plane of motion to a typical movable core. To accomplish spotting of a movable core, the mold half that communicates therewith is usually set on a work table or similar apparatus, and in a position that will allow the mating portion of the mold to best receive the movable core while still permitting access thereto for making adjustments. The movable core is then typically placed,

by hand, into proper relation with the mold half, and checked for fit by placing spotting compound on areas of concern and manually causing the movable core to be set to, and retracted from the mold. Adjusting the fit of the movable core to the mold typically requires numerous repetitions of setting and retracting the movable core, and welding and/or grinding on one, or both, of the movable core and the mating portion of the mold.

[0006] While manual manipulation of movable cores may be acceptable for smaller molds, on molds of relatively large size the movable cores may themselves exhibit substantial dimensions. Large movable cores are generally designed to be moved by a mating mold component or by hydraulic power derived from a molding press during the molding cycle - not by hand. Thus, with the intended method of movable core actuation generally not available for use during the spotting process, fitting a large movable core to a mold for spotting may require the use of, for example, a crane, pry bars, hammers and various other tools to lift the movable core into position and simulate its motion. For example, a crane may be required to lift the movable core to the mold, pry bars may be used to place the movable core into contact with the mating portion of the mold, and a slide hammer or similar device may be used to retract the movable core therefrom - after which the crane may again be required to remove the movable core to another location where operations such as grinding or welding may be performed thereon.

[0007] As the number of adjustments required to place the movable core and mating mold portion into proper relation may be considerable, a substantial expenditure of time by the person or persons performing the spotting operation is often required. In addition, the frequent handling of large movable cores by this

technique also presents an increased possibility of damage to the main mold portion and movable mold cores. Therefore, it would be advantageous during the mold development process if it were possible to spot a movable core without having to repeatedly remove the movable core from the mold.

[0008] The present invention satisfies this need. The present invention discloses a movable mold core spotting method and apparatus that enables a mold, or a portion thereof, to be placed on a support structure or similar device designed to receive the mold and ensure its position. Each movable core requiring spotting is placed and aligned with the portion of the mold to which the movable core mates. A coupling means is provided for connection to each of the movable cores needing spotting. Each coupling means is further connectable to a force exerting device, such as, for example, a hydraulic cylinder, that may be activated to cause movement of the movable core or cores to which it is attached. Preferably, the force exerting device, or devices, are located substantially beneath the support structure, but alternatively, may be located outboard of each movable core. The location of each hydraulic cylinder or other force exerting device is preferably adjustable in three dimensions to provide for differences in location, center of mass, stroke length and other characteristics of the different movable cores to which the hydraulic cylinders will be attached. Other force exerting devices may also be employed depending upon the size of the movable cores involved, including, for example, pneumatic cylinders, and electric motors and gear assemblies.

[0009] When a hydraulic cylinder is provided to move a movable core, a hydraulic pump and reservoir is also provided to supply pressurized hydraulic fluid to the cylinder. Upon actuation of the hydraulic cylinder, the movable core may be set

to, or retracted from, the mating portion of the mold without physical exertion by the worker involved. A flow control or similar device is preferably provided to afford control over the speed of movement of the movable core. The apparatus of the present invention is also preferably capable of retracting the movable core to a position which allows for ample accessibility to both the movable core and the section of the mold with which the movable core communicates.

[0010] Thus, the method and system of the present invention allows for the effective and efficient spotting of one or more movable mold cores, wherein the installation and removal of the movable core to the mold is minimized, and required movement of the movable core is accomplished by a force exerting device. The present invention minimizes damage to mold components, while also reducing the time necessary to successfully perform the core spotting operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In addition to the novel features and advantages mentioned above, other objects and advantages of the present invention will be readily apparent from the following descriptions of the drawings and exemplary embodiments, wherein like reference numerals across the several views refer to identical or equivalent features, and wherein:

Figure 1 is a front view of one embodiment of a movable mold core spotting apparatus of the present invention, having a mold half residing thereon;

Figure 2 is a top view of the movable mold core spotting apparatus of Figure 1;

Figure 3 is a left-side view of the movable mold core spotting apparatus of Figure 1;

Figure 4 is a front view depicting an alternate embodiment of a movable mold core spotting apparatus of the present invention; and

Figure 5 is a front view depicting another exemplary embodiment of a movable mold core spotting apparatus of the present invention.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENT(S)

[0012] An exemplary embodiment of a movable mold core spotting apparatus **10** of the present invention is illustrated in Figures 1-3. While the particular embodiment depicted in Figures 1-3 shows a plastic bumper mold half **20**, it should be realized that such an apparatus may be adapted for use with other molds of varying type and size.

[0013] In this particular embodiment, it can be seen that the movable mold core spotting apparatus **10** has a support structure **30**. The support structure **30** preferably employs one or more vertical risers **40** or similar devices to buttress the mold half **20**. Some, or all of the vertical risers **40** may be connected by cross-bracing **60** to help provide lateral strength to the support structure **30**. As shown in this particular embodiment, an upper portion of the vertical risers **40** may be attached to, or otherwise communicate with a horizontally oriented support plate **50** that is adapted to accept the mold half **20**. Alternatively, the vertical risers **40** may support the mold half **20** without the use of a support plate **50**, such as, for example, by contacting the upper portion of the vertical risers directly with the mold back plate **90**. It should be realized that the support structure **30** shown in Figures 1-3 is for

purposes of illustration only, and support structures of other construction may also be employed without departing from the spirit and scope of the present invention.

[0014] If a support plate **50** is utilized, the upper surface **70** thereof is preferably equipped with dowel pins or other similar locating elements (not shown). These locating elements are provided to mate with corresponding features located on the back surface **80** of the back plate **90** of each mold that will be placed on the movable mold core spotting apparatus **10**. If a support plate **50** is not employed in the support structure **30**, similar locating elements may be affixed to the top portion of the vertical risers **40** or other support devices used. Although locating elements are not required to practice the present invention, the use of such locating elements helps to ensure the proper alignment and repeated relocation of each mold to the movable mold core spotting apparatus **10**.

[0015] Preferably attached to the support structure **30** are one or more core moving devices **100**, **100'**, each of which generally consists of a force exerting device and a means for coupling the force exerting device to the movable core to which the force exerting device corresponds. Although various force exerting devices may be employed for this purpose, including, for example, pneumatic cylinders or electric motors and gear assemblies, in the specific embodiment shown in Figures 1-3 a separate hydraulic cylinder **110**, **110'** is used to cause movement of each of two movable cores **120**, **120'** (Figures 2 and 3). Alternatively, it should also be realized by one skilled in the art that a single force exerting device may be employed to move more than one movable core - such as may be accomplished, for example, by a double-rodded cylinder. When a support plate **50** is utilized, as shown in Figures 1-3, each force exerting device may be affixed thereto by a mounting plate

210, **210'** or similar means. When a support plate **50** is not used, each force exerting device may be similarly attached to the vertical risers **40** or other support devices employed.

[0016] In this embodiment, each hydraulic cylinder **110**, **110'** is preferably attached to a drive arm **130**, **130'** via a cylinder coupling **140**, **140'**. The cylinder coupling **140**, **140'** may be rigid, or alternatively, may be flexible to allow for mismatch between the hydraulic cylinders **110**, **110'** and the other components of each core moving device **100**, **100'**. In an alternate embodiment, the rod of the hydraulic cylinders **110**, **110'** may be attached directly to the drive arms **130**, **130'** without the use of a cylinder coupling **140**, **140'**, such as by threaded engagement, for example.

[0017] Each of the drive arms **130**, **130'** are preferably affixed to the respective movable cores **120**, **120'** by means of a core-coupling assembly **150**, **150'**. Although other component combinations are possible, each of the core-coupling assemblies **150**, **150'** may consist of a connector **160**, **160'** and mounting plates **170**, **170'**, **180**, **180'** for attaching the connector to the proper drive arm **130**, **130'** and movable core **120**, **120'**, respectively. The connector **160**, **160'** may be of various configuration, such as, for example, a rod, a block, or a multitude of other structures that may suitably couple the drive arms **130**, **130'** to the movable cores **120**, **120'**. The connector **160**, **160'** may further be threaded or otherwise shaped to allow for quick attachment to the movable cores **120**, **120'** and the drive arms **130**, **130'** - with, or without mounting plates. The movable core mounting plates **180**, **180'** may make use of tapped holes or similarly existing features of the movable cores **120**, **120'** to provide for attachment.

[0018] Molds and movable mold cores of substantial size and weight may be placed on the support structure **30** for spotting purposes. Consequently, certain components of each core moving device **100**, **100'**, such as the drive arms **130**, **130'** and hydraulic cylinders **110**, **110'** must be of correspondingly suitable size. It has been found that on drive arms **130**, **130'** of extended length, one or more guide pins **220**, **220'** or similar directing devices may be beneficial, although not essential, to obtaining the proper linear movement of the drive arms and corresponding movement of the movable cores **120**, **120'**. The guide pins **220**, **220'** may be located below and in line with the hydraulic cylinders **110**, **110'**, as can be seen especially by reference to Figure 3. Alternatively, guide pins **220**, **220'** may be located only above, only below, or only in line with the hydraulic cylinders, or various combinations of guide pin locations may be employed. As described above with reference to the mounting of the force exerting devices, the guide pins **220**, **220'** may be attached via the mounting plate **210**, **210'** or similar means to the support plate **50**, if a support plate is used, or may also be attached to the vertical risers **40** or other support devices employed.

[0019] Although not necessary, one or more stops **230**, **230'** may be utilized to assist in controlling the inward-most stroke limit of each core moving device **100**, **100'**. The stops **230**, **230'** may further act to cushion the impact of the movable cores **120**, **120'** against a main core **190** of the mold **20** by contacting the drive arms **130**, **130'** and absorbing the energy of movement thereof. The stops **230**, **230'** may be of a solid material, may be of a deformable material, such as, for example, urethane or similar rubbers, or may be of spring-loaded or hydraulic construction.

[0020] As can be seen in Figures 1-3, the mold half **20** is placed on the support structure **30** and preferably releasably affixed to the optional support plate **50** by means of bolts or the like. The mold half **20** is shown to have a main core **190**, to which each of the movable cores **120**, **120'** mate. In this particular mold, the movable cores **120**, **120'** are used to form an undercut **200**, **200'** in the finished part, and may also form other features located therein, such as, for example, slots or mounting holes. To accomplish the formation of this undercut **200**, **200'**, the movable cores **120**, **120'** are caused to slide into, and out of, communication with the main core **190** during the molding cycle.

[0021] Although each mold placed on the movable mold core spotting apparatus **10** may be of similar size and geometry, it is also possible that the movable mold core spotting apparatus may be used to perform spotting on dissimilar molds. Therefore, it is preferable that each of the core moving devices **100**, **100'** be adjustable in preferably three dimensions, as indicated by the XYZ labeled arrows shown in each of Figures 1-3. For example, the hydraulic cylinder **110**, **110'** portion of each core moving device **100**, **100'** may be adjustable in the ±Y direction to account for the different center lines or centers of mass of the movable cores attached to different molds. The hydraulic cylinder **110**, **110'** portion of each core moving device **100**, **100'** may also be adjustable in the ±X direction to allow for different mold lengths, and variable movable core sizes and stroke distances. Adjustment of the hydraulic cylinder may be accomplished **110**, **110'** by, for example, a rack and pinion system, and/or by slotted mounting hardware. Similarly, the drive arm **130**, **130'** may be designed to accommodate different hydraulic cylinder **110**, **110'** to movable core **120**, **120'** distances, such as by slotting, thereby allowing the

vertical (±Z) adjustment thereof. Graduated scales, levels, or similar other measuring devices may be placed on the movable mold core spotting apparatus **10** to assist in properly aligning each of the core moving devices **100**, **100'** with the corresponding movable cores **120**, **120'**.

[0022] To use the movable mold core spotting apparatus **10** of the present invention, an operator first places the proper mold or mold half **20** on the support structure **30** and preferably releasably affixes it to the support plate **50** or vertical risers **40**, depending upon the particular configuration thereof. Each movable core **120**, **120'** that will be spotted using the movable mold core spotting apparatus **10** is then preferably placed into proper communication with the mating portion of the main core **190**, although the movable cores could also be placed into communication with the mold and spotted one at a time. Typically, each movable core **120**, **120'** is aligned using a guiding means (not shown) provided on the mold **20** to direct the motion of the core.

[0023] The location of the appropriate core moving device **100**, **100'** may then be adjusted as needed for proper connection to the respective movable core **120**, **120'**, and connected thereto. In the case of the embodiment shown in Figures 1-3, which uses a hydraulic cylinder **110**, **110'**, a hydraulic pump (not shown) that is connected to a hydraulic fluid reservoir (not shown) is then turned on. The hydraulic pump and hydraulic fluid reservoir may be located at the movable mold core spotting apparatus **10**, or may be located remotely. Preferably, flow controls or similar mechanisms are utilized and adjusted to prevent high-speed travel of the movable cores **120**, **120'** upon energizing of the hydraulic cylinders **110**, **110'** or other force exerting devices.

[0024] A remote actuator (not shown) may be provided for use by the operator of the movable mold core spotting apparatus **10**. The remote actuator allows the operator to cause movement of the movable cores **120**, **120'** while maintaining some distance therefrom. Preferably, the movable cores **120**, **120'** may be moved individually, or together, as desired by the operator. Because of possible pinch points between the movable cores **120**, **120'** and the main core **190** to which the movable cores mate, pressure sensitive mats, photosensors, or other similar safety devices may be employed to prevent an operator from energizing the hydraulic cylinders **110**, **110'** or other force exerting devices while the operator is within a predetermined work envelope.

[0025] Areas of concern on the movable cores **120**, **120'** and/or on the mating mold portion may be coated with spotting compound, and the movable cores moved into contact with (set to) the mold half **20** by energizing the appropriate mold core moving device **100**, **100'**. The movable cores **120**, **120'** may then be retracted from the main core **190** and checked for indications of contact. Preferably, each core moving device **100**, **100'** retracts the corresponding movable core **120**, **120'** to a position that is sufficiently removed from the main core **190** to allow welding, grinding or other operations to be performed on the movable core without having to remove the movable core from the movable mold core spotting apparatus **10**. This retracted position preferably also allows for accessibility to the mating portion of the main core **190**, thereby permitting the performance of similar work thereon if needed. If necessary, spacer plates **240**, **240'** of appropriate thickness may be placed on the top surface **70** of the support plate **50**, and substantially against an edge of the mold back plate **90**, to provide an increased surface area for retraction of the movable

cores **120**, **120'**. The setting and retracting of the movable cores **120**, **120'**, and adjustment thereof, may be repeated as many times as is necessary to achieve the proper fit of the movable cores to the mold.

[0026] An alternate embodiment of a movable mold core spotting apparatus **300** of the present invention is shown in Figure 4. It can be seen that the movable mold core spotting apparatus **300** of Figure 4 is similar to the movable mold core spotting apparatus **10** of Figures 1-3, except that the force exerting devices, in this case, hydraulic cylinders **310**, **310'**, are located outward and substantially in line with the movable cores rather than under the support structure **320**. Hydraulic cylinder mounting brackets **330**, **330'** may be used to attach the hydraulic cylinders **310**, **310'** to the support structure **320**. A cylinder coupling **340**, **340'**, similar to that discussed above, may be utilized to connect each hydraulic cylinder to the respective movable core. Alternatively, the hydraulic cylinder rods **350**, **350'** may be threaded, may fit into a slotted plate, or may otherwise be adapted for quick attachment to, and detachment from, the movable cores.

[0027] Preferably, the movable mold core spotting apparatus **300** allows for the relationship between the hydraulic cylinders **310**, **310'** and the movable mold cores to be adjusted in preferably three dimensions. This may be accomplished, for example, by slotting the hydraulic cylinder mounting brackets **330**, **330'** to provide for location adjustment of the hydraulic cylinders **310**, **310'** in the ±X and ±Y directions, and placing spacers under the hydraulic cylinder mounting brackets to allow adjustment in the ±Z direction. The adjustments just described may be made by hand, or alternatively, could be made by mechanical device, such as, for example, a

rack and pinion. Other means of adjustment are also possible, and are not meant to be foreclosed by the above examples.

[0028] Like the embodiment of the movable mold core spotting apparatus **10** shown in Figures 1-3 and discussed above, the movable mold core spotting apparatus **300** may include a remote actuator that affords a user of the apparatus the ability to stroke the movable cores from outside the work envelope. Pressure sensitive safety mats, photosensors, or similar safety devices may also be provided.

[0029] Referring now to Figure 5, another embodiment of a movable mold core spotting apparatus **400** of the present invention that may be utilized on appropriate molds can be seen. As is shown, the movable mold core spotting apparatus **400** of Figure 5 is similar to the movable mold core spotting apparatus **300** of Figure 4, except that the force exerting devices, in this case, hydraulic cylinders **410**, **410'**, are located in an open area between the main mold core **420** and the top surface of the mold back plate **430** rather than outward of each movable core **440**, **440'**.

[0030] Hydraulic cylinder mounting brackets **450**, **450'** may be used to attach the hydraulic cylinders **410**, **410'** to the main mold core **420**. Preferably, each cylinder mounting bracket **450**, **450'** is provided with slots or other adjusting means to allow for proper alignment of the cylinder to which it is mounted. A height adjusting device **460**, **460'** is also preferably provided on each hydraulic cylinder **410**, **410'** to assist in aligning the center line thereof with the movable core **440**, **440'** to which the cylinder is attached. The hydraulic cylinder rods **470**, **470'** may pass through the movable cores **440**, **440'** as shown, and attach thereto with a coupling member **480**, **480'**. Alternatively, rather than pass through the movable cores **440**,

440', the hydraulic cylinder rods **470**, **470'** may attach to an inside portion thereof. Additionally, in place of utilizing a coupling member **480**, **480'** for attachment, the cylinder rods **470**, **470'** may be threaded, may fit into a slotted plate, or may otherwise be adapted for quick attachment to, and detachment from, the movable cores **440**, **440'**.

[0031] Like the embodiments of the movable mold core spotting apparatus **10**, **300** shown in Figures 1-4 and discussed above, the movable mold core spotting apparatus **400** may include a remote actuator that affords a user of the apparatus the ability to stroke the movable cores from outside the work envelope. Pressure sensitive safety mats, photosensors, or similar safety devices may also be provided.

[0032] The movable mold core spotting apparatus and method of spotting a movable mold core disclosed by the present invention provides for a higher quality, and more efficient spotting operation. The improved accuracy and repeatability of setting the movable cores permits the spotting process to be accomplished with fewer operations and in less time. The reduced handling of the movable cores minimizes the likelihood that damage to the movable cores or other portions of the mold will occur.

[0033] For purposes of illustration, and not limitation, certain exemplary embodiments of a movable mold core spotting apparatus and method of spotting a movable mold core have been described above. While these embodiments are representative of what is contemplated by the present invention, the scope of the invention is not to be considered limited by such disclosure, and modifications are possible to both the apparatus and methods herein described without departing from the spirit of the invention as evidenced by the following claims: